

The ambiguous role of DNA-testing in dog breeding

- What breeders want is not always what they need

Helle Friis Proschowsky, Camilla S Bruun & Merete Fredholm

UNIVERSITY OF COPENHAGEN



Breeding programs based on clinical investigations or imaging has a long history in dog breeding

- Hip dysplasia
- Elbow dysplasia
- Eye diseases
- Heart diseases
- BOAS-grading
- Mentality assessments



HD grade A



HD grade C

DNA-tests in dogs

- A mutation causing Haemophilia B was identified in 1989
- Dog genome was published in 2005
- Rapid increase in DNA-test, first for simple mendelian traits
 - PRA, coat colours etc.
- New methods were developed
 - WGS (Whole Genome Sequencing)
 - GWAS (Genome Wide Association Study)
- Complex diseases – risk mutations



The DNA-tests were well received by dog breeders

- Many breeders perceive the DNA-test results as more “correct” or “precise” compared to other screening programs
 - HD-evaluations questioned – “I don’t believe my dog has grade C”
- There are indeed many benefits
- Possibility to identify the carriers for simple Mendelian traits
 - Inherited eye disease prcd-PRA
 - Eye examinations are only able to identify affected dogs
- Early diagnosis
 - prcd-PRA is a late-onset disease
 - Requires yearly re-examinations
- DNA-tests quickly became the breeder’s “darling”

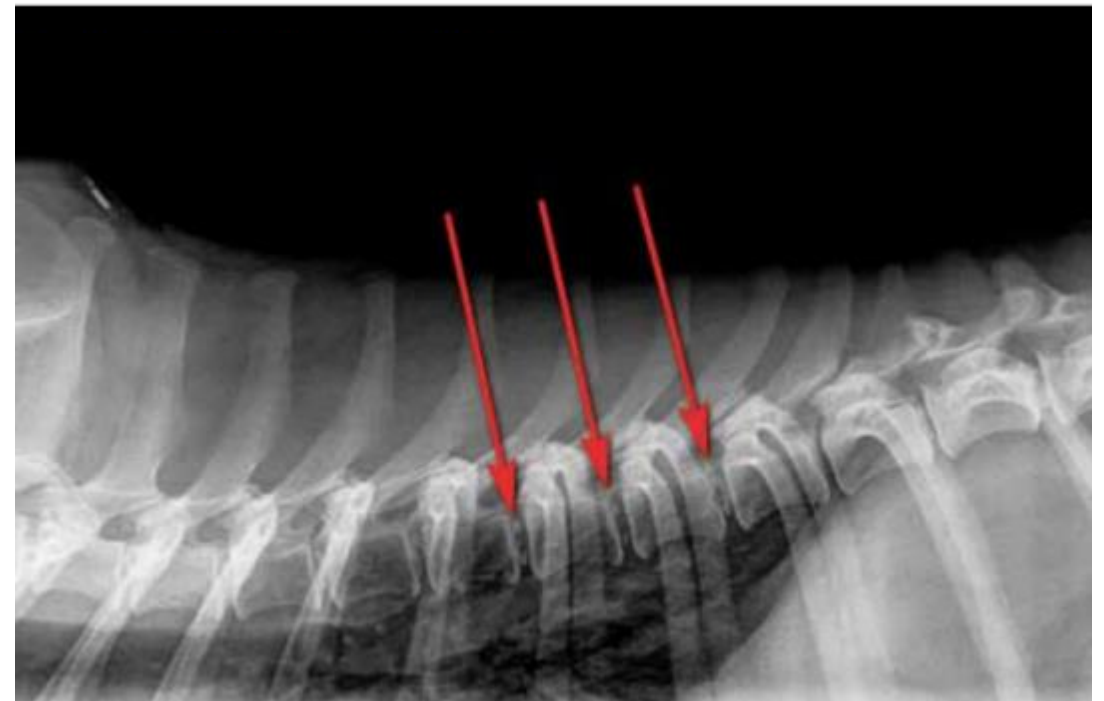
But is it always the best tool to use?

- IVDD – Intervertebral Disc Disease
- Painful and debilitating disease
- Affects approximately one in five Dachshunds
- “The long back” was previously seen as the main cause
- IVDD is - at least to some extent - related to the chondrodystrophic phenotype
 - Calcification of the intervertebral discs

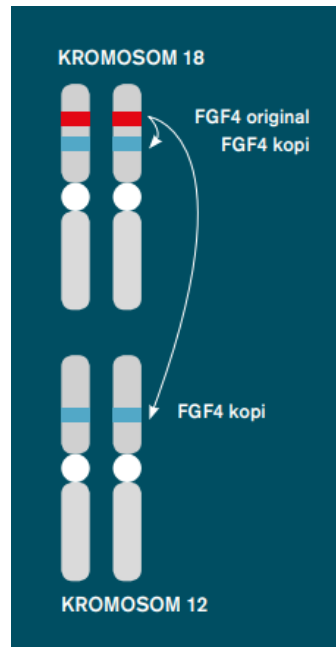


Correlation between the number of calcified discs and the risk of IVDD

- Danish ph.d.-project by Vibeke Frøkjær Jensen
- > 5 calcified discs increase the risk of disc herniation more than tenfold
- Number of calcified discs have a high heritability (~ 0.60)
- A breeding program based spinal X-rays between 24 and 48 months of age was implemented for Danish Dachshunds in 2009
- Estimated Breeding Values



The FGF4 retrogene was identified affecting both leg length and risk of disc herniation (IVDD)



Extra copies on chromosome 18

- Short legs, moderate risk of IVDD (Cairn terrier, Westie)

Extra copies on chromosome 12

- Moderate leg length, increased risk of IVDD (French bulldog, Beagle)

Extra copies on chromosome 12 + 18

- Short legs, increased risk of IVDD (Dachshund, Welsh corgi)

DNA-test – CDDY (Chondrodystrophy)

- Testing the FGF4 copies in Chr.A 12
- Dominant effect – increased risk also in the heterozygotes

Danish study

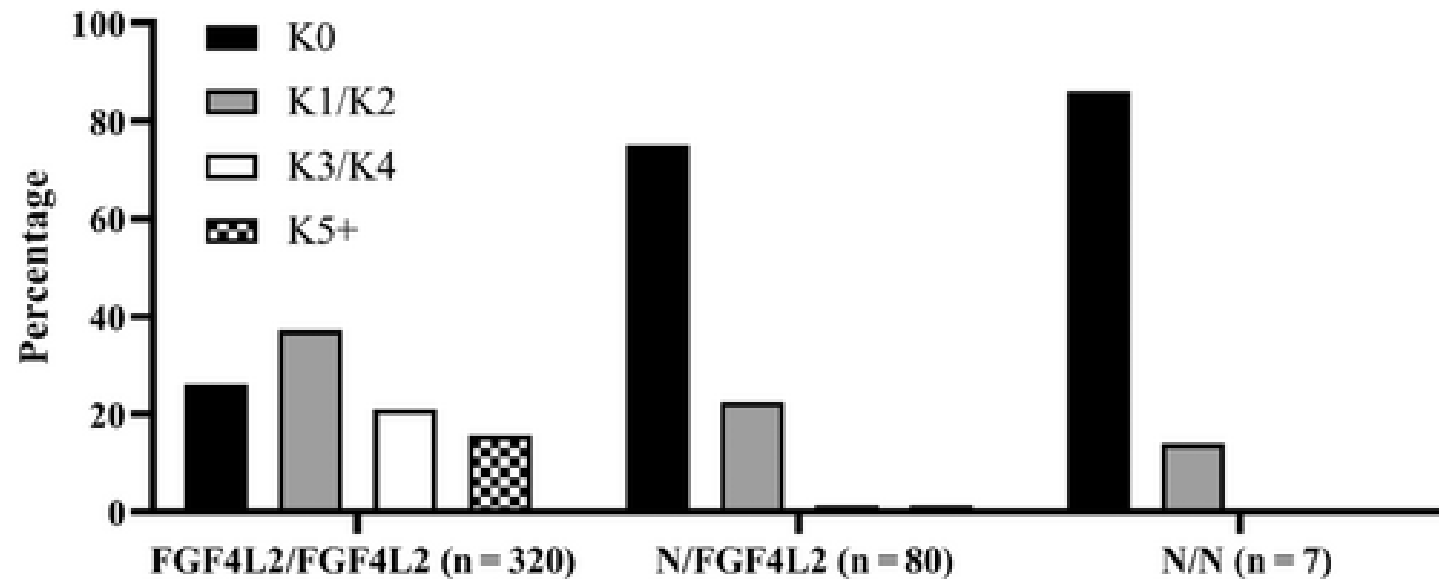
- 151 Dachshunds
- Very few N/N dogs

Table 4 Genotyping of the *Ins* allele in wire-, long- and smooth-haired Dachshunds with ≥ 5 and < 5 calcifications

Number of calcifications	<i>Ins/Ins</i>	<i>Ins/N</i>	<i>N/N</i>	Total	X^2	<i>p</i> -value
Wire-haired					37.13	< 0.0001
≥ 5	32	1	0	33	0.22	0.89
< 5	15	29	7	51		
Total				84		
Long-haired					0.22	0.89
≥ 5	13	0	0	13	3.75	0.15
< 5	22	0	0	22		
Total				35		
Smooth-haired					3.75	0.15
≥ 5	17	0	0	17		
< 5	12	2	1	15		
Total				32		

Similar study on 407 dogs from Norway and Finland

- Dogs with 1 or 2 N alleles are more likely to have K0, K1, K2
- Lower risk of disc disease than the breed average
- But - the frequency for the FGF4-allele was 0.88



DNA-test or X-ray/EBV?

- The breed has a painful disease with a high prevalence
- There is a well-established breeding program based on X-rays and EBV
 - It is age-restricted in Denmark
- There is DNA-test for a mutation which increases the risk of IVDD
- Breeders are recommended to continue radiographic screening
- The gene pool is at risk if only N/N dogs are used for breeding
 - Breeders tend to look at all DNA-tests like they were for mendelian trait
 - The few N/N males are being overused (popular sires)

The ambiguous role of DNA-testing in dog breeding

- Genetic counselling has become much more complex
- DNA-test are very useful in some breeding programs
 - But can be the opposite in others
 - Exclusion of too many dogs
 - Focus on the wrong things
- "if you have a hammer in your hand, you tend to see every problem as a nail"
 - The quote is attributed to Abraham Maslow and refers to an over-reliance on a familiar or favorite tool
- Counselling about interpretation, validity and relevance is needed

Thank you

- **Danish Dachshund Breed Club**
- **Danish Kennel Club**

